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III. Improving the Efficiency of the Grain-Feeding Operation on Poultry and Dairy Farms

By

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Distributing and Handling Grain-Feeds in New Hampshire

III. Improving the Efficiency of the Grain-Feeding Operation on Poultry and Dairy Farms

By

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And

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1. Introduction

OPPORTUNITIES exist for improvements in methods of receiving, storing, and handling grain-feeds on New Hampshire farms. Such changes can result in time savings in feeding, lessened physical effort, reduced feed wastage and/or feed costs, and, in some instances, in lowered operating costs. Hence, as one phase of a broader project the New Hampshire Experiment Station studied methods in use in this and other areas, with a view to providing information helpful to farm operators in improving the efficiency of the grain-feeding operation. Bulk feed was considered as one of the alternatives. A research mimeograph dealt with bulk feed on poultry farms.†

Another phase of the project dealt with distribution practices, discussing such matters as the present structure of the grain-feeds industry in the state, pricing and distributing methods, delivery route efficiency and costs, and the relative merits of bagged and bulk feed from the dealer's standpoint. Conclusions with respect to delivery route efficiency and costs are in part dependent upon the facilities for receiving and storing grain-feeds at the farm.‡ Farm facilities are in turn closely linked with the degree of efficiency which can be obtained in feeding time.

The diversity of housing facilities and methods for receiving, storing, and handling grain-feeds on New Hampshire farms, as well as variations in unit size, suggests each farm must be treated as an individual case. To find the optimum method, analysis of alternatives must be made in terms of benefits and costs.

This study was confined to poultry and dairy farms, inasmuch as these types of farms predominate in the state. Any economies in feed handling and distribution are likely to be extended first to users of poultry and dairy feeds. Poultry and dairy farming account for about four-fifths of cash re-

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* Professor Woodworth originated this study and initiated much of the field work prior to his death on September 18, 1953.

† Woodworth, H. C. *Handling Grain in Bulk on New Hampshire Poultry Farms*, N. H. Agr. Exp. Sta., Ag. Ec. Res. Mimeo. No. 11, Jan. 1, 1953.

‡ Rogers, G. B., and H. C. Woodworth, N. H. Agr. Exp. Sta. Bul. No. 426 and 427, July, 1956.

ceipts from farming in New Hampshire, and about 95 percent of cash receipts from livestock and products (Table 1). In 1953, over 95 percent of grain-feed requirements in the state were accounted for by poultry and dairy cattle.*

Table 1. Cash Receipts from Farming in New Hampshire, by Enterprises, 1949 and 1953

Enterprise	1949 ($1,000)	1949 % of Total	1953 ($1,000)	1953 % of Total
Eggs	$18,250	29.2	$22,411	30.8
Broilers	9,574	15.3	7.448	10.2
Chickens			6,726	9.2
Turkeys	——	——	922	1.3
All poultry[1]	27,824	44.5	37,507	51.5
Dairy products	17,056	27.2	19,390	26.6
Cattle and Calves	3,967	6.3	2,746	3.8
Other livestock[2]	1,334	2.1	1,385	1.9
Livestock and products	50,181	80.1	61,028	83.8
Crops	12,442	19.9	11,769	16.2
All Commodities	62,623	100.0	72,797	100.0

[1] Includes turkeys in 1953, but does not include miscellaneous poultry in 1949 or 1953.
[2] Includes turkeys in 1949, and miscellaneous poultry in 1949 and 1953.

Source: Farm Income Situation, Bureau of Agricultural Economics and Agricultural Marketing Service, U. S. Department of Agriculture.

Mixed grain-feed is the principal cash cost in poultry and dairy production. Purchased feed may account for 65-70 per cent of unit costs of producing market eggs. On central Northeast dairy farms in 1953, feed purchased accounted for about 36 percent of cash expenditures.† Feeding constitutes a major share of chore time on poultry farms. Feeding grain to dairy cattle does not take a very significant share of total chore time, but any reduction effected may be enhanced since it occurs during the critical time periods of the day.

Among the considerations pertinent to effectuating economies in the grain feeding operation on New Hampshire poultry and dairy farms are the following:

(1) Bulk feed.

(2) Size of business.

(3) Type of housing.

(4) Arrangement of facilities.

(5) Organization of the chore program.

(6) Feeding practices.

(7) Time savings vs. costs of installation or remodelling.

* N. H. Agr. Exp. Sta. Bul. 426, Table 4.

† *The Farm Cost Situation*, Agr. Res. Ser., U. S. Dept. Agr., Oct., 1954, Table 13, p. 37.

2. Bulk Feed Handling on the Farm

IN grain growing sections, bulk handling has been common practice for many years. Beginning on the West Coast shortly after the end of World War II and gradually extending to the east coast, grain dealers have equipped themselves with special trucks designed for delivering grain in bulk. For over three years, several New Hampshire firms have made grain in bulk available to their patrons at a price discount.

A few farm operators for many years have purchased grain in bags, emptied it into bins and from there on handled it in bulk. One of the reasons for doing this was the inability of some of the help to handle 100-pound bags. But for most New Hampshire farmers handling grain in bulk on the farm is a relatively new innovation.

The initial effort of this study was largely directed toward the appraisal of the handling of feed in bulk. It soon became apparent that bulk feed could be neither universally recommended nor adopted by dealers or by farmers. From the feed dealer's standpoint there are additional investments and a difficult problem of establishing efficient delivery routes in many areas. On the farm, the diverse nature of facilities, as well as varying unit sizes, makes the decision in each case an individual problem.

There are a number of factors which bear upon the decision on whether or not to shift from bagged to bulk-grain delivery on any particular farm. These are:

(1) Availability of the service.

(2) Accessibility of the farm.

(3) Cash savings on purchase price of feed.

(4) Indirect savings.

(5) Alternatives, benefits, costs.

(6) Effects on the labor force.

Availability of the Service.

In some areas of the state it is feasible for the feed dealer to offer conventional bulk-feed delivery service. However, there are many areas where there are too few units of sufficient size to justify operation of bulk delivery. Thus, it is conceivable that some relatively large poultry and dairy farms would be forced to continue handling bagged feed. At the present time distribution of bulk feed in New Hampshire is confined to within a given radius of milling facilities, except as some dealers may elect to subsidize bulk delivery by resorting to the costly method of emptying bags into conventional bulk delivery units.

Recently, an alternative method of delivery has made its appearance. With this system feed is received and loaded on delivery trucks in bags. Delivery at the farm involves a hopper, into which bagged feed is dumped, and an elevating mechanism mounted on the delivery truck. The unit can be used to deliver feed in bulk to the farm bins where unit size warrants, while serving other units with regular bagged-feed delivery. Under some circumstances this might overcome the present disadvantage of units receiving bagged feed by rail from distant mills but called upon for bulk-delivery service, or the cost difficulties experienced in setting up both efficient bulk and bagged-delivery routes, even where each form is available at distributing points by rail.

The present inclination of dealers offering conventional bulk-feed delivery seems to be to limit deliveries to a minimum of two tons per farm (and preferably per setting of the truck). The bulk-feed trucks in use in the state generally have four compartments, each holding approximately two tons of feed. The use of this heavy equipment for less than the two-ton unit is probably impractical as a general rule, except where a limited number of one-ton loads could be worked into a route to maintain the total load as near to capacity as possible. However, the minimum delivery unit established by the dealer will determine the availability of the service to the farm.

Whatever that minimum unit happens to be, there are two other points which will affect availability of bulk-feed service. Many companies base their sales policy in part upon supplying "fresh feed" to their customers. In terms of nutritive values, such claims may sometimes be exaggerated. However, there is insufficient experimental evidence upon which to reach definite conclusions as to how long feed may be stored under farm conditions without undue loss of palatability and/or nutritive content. Obviously, if this is one week, rather than a month, it would have great bearing on the minimum flock or herd size which could be bulk-serviced. For example, if the feed dealer insists upon a minimum delivery of two tons and feels it

Table 2. Number of Animal Units Required for Minimum Deliveries of Bulk Feed Under Assumed Conditions

Class of Livestock	Every Week 2 tons (No. head)	Every 2 Weeks 2 tons (No. head)	Every 3 Weeks 2 tons (No. head)	Every 4 Weeks 2 tons (No. head)
Milk Cows[1]	108	54	36	27
Laying Hens[2]				
30%	2,041	1,020	680	510
50%	1,905	952	635	479
70%	1,786	893	595	446
Commercial Meat Chickens[3]				
1 week old	20,000	10,000	6,667	5,000
2 weeks old	13,333	6,667	4,444	3,333
3 " "	8,000	4,000	2,667	2,000
4 " "	6,667	3,333	2,222	1,667
5 " "	5,000	2,500	1,667	1,250
6 " "	4,444	2,222	1,481	1,111
7 " "	3,637	1,818	1,212	909
8 " "	3,333	1,667	1,111	833
9 " "	2,857	1,429	952	714
10 " "	2,500	1,250	833	625
11 " "	2,353	1,176	784	588
12 " "	2,105	1,053	702	526
13 " "	2,000	1,000	667	500
14 " "	1,818	909	606	454
15 " "	1,667	833	556	416
16 " "	1,600	800	533	400
17 " "	1,600	800	533	400
18 " "	1,667	833	556	416
19 " "	1,739	869	580	434
20 " "	1,739	869	580	434

[1] 1930 pounds per cow annually. G. B. Rogers and H. C. Woodworth, N. H. Agr. Exp. Sta. Bul. 426, Table 3.

[2] Rates of consumption from: G. E. Frick and W. K. Burkett, *Farm Management Reference Manual*, University of N. H. Ext. Service and BAE Cooperating, Ext. Circ. 307, Sept. 1953, p. 17.

[3] *Ibid.*, p. 17, for mixed sexes.

is inadvisable to carry feed longer than two weeks on the farm, a farm with 1,000 layers might receive bulk delivery. If one month is a feasible holding period, a farm with 500 layers could be so serviced.

A second consideration relating to minimum delivery size is the number of separate feeds used. For example, under conditions where the feed dealer insists on a minimum delivery of two tons, and feels it is inadvisable to carry feed longer than two weeks on the farm, a farm with 1,000 layers, and feeding an all-mash ration, might receive bulk delivery. On the other hand, with the two-ton two-weeks' policy and a mash-scratch ration, 2,000 layers might be the minimum unit serviced (Table 2).

The adoption of less frequent delivery of feed, whether bagged or bulk, would involve some adjustments relative to scheduling payments, both by the farmer and the dealer.

Feed consumption per animal unit varies with body size, level of production, or age. Leghorns vs. heavy breeds, or Jerseys vs. Holsteins are examples of differences in consumption due to body size. Table 2 contains estimates of consumption for laying hens of heavy breeds laying 30, 50, or 70 per cent. Similar variations could be shown for milk cows of comparable size, but producing at different rates. The effect of age of birds on feed consumption is also shown in Table 2, where estimates are expressed in terms of the number of birds, according to age, which would consume two tons of feed over the indicated periods.

In Table 3, the data show the tons of feed consumed by chickens, according to age, for several sizes of flock on both a weekly and cumulative basis. This table is useful in illustrating a particular problem which may arise in considering whether or not to extend bulk feed service to meat chicken flocks or birds being grown for laying flock replacement. If a dealer can justify infrequent delivery for the first few weeks, or preferably, service with bagged feed, the minimum number of growing chickens needed to justify bulk-feed service is rather low after that period. In practice, this adjustment on growing stock might involve the following:

(a) On farms where there is a laying flock:

(1) Bulk feed for layers.

(2) Bagged feed for replacements carried on side racks of bulk truck for a few weeks.

(3) Bulk feed for replacements after a few weeks.

(b) On farms where meat production predominates:

(1) Bagged feed for a few weeks out of the nearest store, and worked into regular routes.

(2) Bulk feed after a few weeks.

Accessibility of the Farm Storage.

Inaccessibility may preclude some farms from consideration for bulk feed delivery. Weight limits, width, overhead clearance, and seasonal variations in road and driveway conditions, as well as maneuvering room, need to be taken into account.

The location of better agricultural lands and/or farms has apparently been given only minor consideration in the building of improved roads.

There has been little change in this respect since 1942, when it was concluded that:

"Inadequate rural road services in New Hampshire have contributed to an uneconomic use of rural land and to an incomplete realization of agricultural and recreational opportunities. . . .a large majority of the so-called 'declining areas' are those districts most inaccessible in a town. . . .many of the declining areas are made unfit for agriculture by uncontrollable natural forces, ...Nevertheless, too many areas in the state are declining because they are not readily accessible. . . ."*

Table 3. Weekly and Cumulative Feed Consumption for Selected Flock Sizes of Growing Birds

Age in Weeks	Tons of Feed Consumed by: 2,000 birds		5,000 birds		10,000 birds	
	Weekly	Cumulative	Weekly	Cumulative	Weekly	Cumulative
1	.2	.2	.5	.5	1.0	1.0
2	.3	.5	.75	1.25	1.5	2.5
3	.5	1.0	1.25	2.5	2.5	5.0
4	.6	1.6	1.5	4.0	3.0	8.0
5	.8	2.4	2.0	6.0	4.0	12.0
6	.9	3.3	2.25	8.25	4.5	16.5
7	1.1	4.4	2.75	11.0	5.5	22.0
8	1.2	5.6	3.0	14.0	6.0	28.0
9	1.4	7.0	3.5	17.5	7.0	35.0
10	1.6	8.6	4.0	21.5	8.0	43.0
11	1.7	10.3	4.25	25.75	8.5	51.5
12	1.9	12.2	4.75	30.5	9.5	61.0
13	2.0	14.2	5.0	35.5	10.0	71.0
14	2.2	16.4	5.5	41.0	11.0	82.0
15	2.4	18.8	6.0	47.0	12.0	94.0
16	2.5	21.3	6.25	53.25	12.5	106.5
17	2.5	23.8	6.25	59.5	12.5	119.0
18	2.4	26.2	6.0	65.5	12.0	131.0
19	2.3	28.5	5.75	71.25	11.5	142.5
20	2.3	30.8	5.75	77.0	11.5	154.0

Hence, while some farm units may have actually gone out of production, in large part because of inaccessibility, many have continued to operate. These oftentimes present a problem to the feed dealer from the standpoint of added route mileage, the fact that roads may be impassable at certain seasons, or the load limits involved may require at times substitute delivery equipment. Although such units are in the minority, they are important.

Because of the heavier truck chassis required for the bulk feed body and unloading equipment, and the additional weight of those items themselves, the adoption of bulk feed delivery tends to increase tare weight. Use of aluminum bodies would help minimize this effect. If a customer taking 5 tons of feed per delivery is located on a road with a load limit of 8 tons gross weight, a truck of 2-3 tons empty weight could make the delivery. However, with a 3-ton chassis and a 2¼-ton bulk body and unloader, a load of 5 tons would gross 10¼ tons, or in excess of the road limit.

During the spring months many New Hampshire roads are virtually impassable due to mud. Hence, a customer normally receiving bulk service

* Parks, W. R., and J. C. Holmes, *New Hampshire Rural Town's Comparative Road Burdens and Road Services*, N. H. Agr. Exp. Sta. and Bureau Agr. Econ. cooperating, Bul. 339, June, 1942, p. 6.

might need to be serviced by a small truck and with bagged feed for the duration of the difficult going. Such special arrangements are obviously less efficient than standardized operations, and coming in number at one time, might deter the introduction of bulk feed service to such units in the first place.

According to the 1950 Congress over 20 percent of New Hampshire farms were located on dirt or unimproved roads. Of 11,925 farms for which data were obtained on distance to trading center over dirt or unimproved roads, almost one-quarter were located where such distance was one mile or more.

Table 4. Location of New Hampshire Farms in Relation to Kind of Road and Distance to Trading Centers Over Unimproved Roads

	Number of Farms
Kind of road on which farm is located:	
Hard surface	8,363
Gravel, shell, or shale	1,903
Dirt or unimproved	2,758
	13,024
Distance to trading center over dirt or unimproved roads:	
0.0 to 0.2 mile	7,739
0.3 to 0.9 mile	1,273
1.0 to 4.9 miles	2,629
5.0 miles and over	284
	11,925

Source: 1950 Census of Agriculture.

Many farms have roads and driveways which are frequently unsatisfactory for non-bulk delivery and which would initially preclude these farms from being serviced by the heavier bulk-feed delivery equipment. Somewhat more room is required for maneuvering bulk delivery equipment into position for unloading than is generally necessary for non-bulk delivery equipment. To provide adequate facilities with respect to the preceding might require cash outlays and building or rebuilding of a magnitude that a farmer would be unwilling or unable to undertake. However, the building of a satisfactory gravel driveway, if that is the particular need, can often be accomplished with small cash outlay. In many areas private or town equipment can be hired at reasonable rates. If the gravel pit is within a reasonable distance, the farm operator may have a 4-5 yard load delivered for $2.50-4.00. Assuming this is spread on the average one foot deep and 9 feet wide, at $4 per load for a 5-yard load, gravel would cost $26.28 per 100 running feet. Total cost of the project would depend on whether extra labor must be hired, and upon the necessity for fill and drainage under the gravel.

Cash Savings on Purchase Price of Feed.

Data reported by three companies offering bulk feed delivery service in New Hampshire indicate that, as of early 1954, producers could realize about $3 per ton net savings on comparable purchases of bulk feed vs. bagged feed (Table 5). Cash and quantity discounts for bagged and bulk feed are about the same. At 100 percent return of No. 1 bags the rebate would almost equal the reduction in bulk prices because of the elimination of bags. To the extent that bags returned are graded down into No. 2's or 3's, the net saving on bulk would be increased. Most of the difference in cost of bulk and bagged feed at the present time is due to an added "bulk discount" of about $.15 per 100 lbs. or $3 per ton. This may be viewed as an incentive to get farmers to shift to the bulk method, or as an estimate of what the feed companies think the net savings to them warrant passing back to the farmer. From preliminary appraisals it seems difficult for feed dealers to realize savings on delivery route costs unless bulk-delivery equipment can be operated close to capacity*. There are some additional investments in facilities at the mill, but some economies in mill operation. Present "bulk discounts" may be revised in light of future cost experience.

However, farmers may continue to realize some net savings on bulk feed. These savings, if projected at the rates in Table 5 should permit farmers to pay for the cost of bulk bins within a relatively short time. Cost of bulk bins may not exceed cost of building materials if the feed companies continue their present policies of furnishing technical advice or labor in constructing the bins. It may be possible to use farm labor at odd times, resorting to a carpenter's service for framing in some cases, or for the complete job in only a few cases.

Table 5. Net Savings Per 100 lbs. to Producers on Bulk Feed as Compared to Bagged Feed, Cash and Delivered, 1954

	Company A[1]		Company B[2]		Company C[3]	
	Bagged Feed	Bulk Feed	Bagged Feed	Bulk Feed	Bagged Feed	Bulk Feed
Discount for cash	$ .20	$ .05	$ .05	$ .05	$ .10	
Discount for quantity		.10	.15	.15	.10	
Bag return credit	.13[4]		.15[4]		.13[4]	
Bag savings on bulk		.15		.15		
Bulk discount		.15		.15		
	.33	.45	.35	.50	.33	.50
Net savings per:						
100 lbs.		.12		.15		.17
Ton		2.40		3.00		3.40

[1] Based on 4 ton minimum on bulk and load of 4 ton or over on bagged feed.
[2] Based on 5 ton quantity discounts for both bagged and bulk feed.
[3] Based on 4 ton minimum on bulk and load of 5 ton or over on bagged feed.
[4] Based upon 100 percent return of No. 1 bags. To the extent that there are damaged bags involved, this average figure would be reduced, and the net savings on bulk increased.

Indirect Savings.

In the handling of bagged feed there is generally some loss experienced through damage to the bags themselves. There is little reason to expect any difference in spoilage of feed under either the bulk or bagged method, but there might well be more wastage using the bagged method. This wastage would be due to spillage from damaged grain bags and to feed adhering to returned bags.

Data from nine New Hampshire poultry farms show considerable variation with respect to the proportions of bags returned for credit which

* Bul. 426, *op. cit.*

graded No. 1. One farm experiencing heavy damage to bags by rats stored feed for longer periods than most farms. Another rather large farm had practically no loss and only 2 percent of its returned bags graded as No. 2. The data on gradings, together with estimated cash losses from a theoretical return of 100 percent No. 1 bags, are presented in Table 6. These losses do not include any costs incurred for rodent control. With metal-lined bins, rodent control costs are largely avoidable. Where damage to bags is heavy the savings from conversion to bulk-feed service would be substantial. If purchases averaged several tons weekly, such savings might go a long way toward paying for the costs of bulk bins. Under more favorable bag return conditions. such savings would be nominal.

Table 6. Estimated Percentages of Returned Grain Bags Graded as No. 1, No. 2, and Loss (or No. 3) on 9 Poultry Farms

	No. Farms	% No. 1	% No. 2	% Loss	Annual cash loss on grain bags when purchasing a ton of grain per week[2]
	1	98	2	0	$ 2.08
	1	95	4	1	5.52
	3	95	3	2	5.82
	2	90	8	2	11.02
	1	85	10	5	17.16
	1	60	15	25	49.40
Total Wtd. Ave.[1]	9	92	5	3	$ 9.26

[1] Weighted by number of birds on each farm.
[2] If 100 percent of bags were returned as No. 1's, and the credit was $.13 per bag, the producer would receive $135.20 per year on the basis of returning the bags from one ton of feed purchased per week (1,040 bags per year). The value of No. 2's is calculated at $.03 per bag, and no value is given to those reported under "loss".

No data were obtained relative to loss of grain from pollution and spillage. One company indicated some bags returned had one-third pounds of grain still remaining in them. In a sample lot of 1,000 bags returned for credit, they recovered $15 worth of discarded grain. At $4.74 per cwt. for feed this would involve 316 pounds of grain, or the equivalent of 6.3 pounds per ton. The same company estimates the residue from a bulk truck at 3-4 pounds, or with an 8-ton load, 0.5 pounds per ton. On a ton basis, and using the preceding figures, a savings of 27.5 cents would be realized with the bulk system of grain handling. Again, this figure would vary depending on the care used in emptying bags of grain.

Alternatives, Benefits, Costs.

Blanket recommendations on the question of investment in bulk bins and facilities are to be avoided. Sound decisions as to investment in equipment and improvements on farms must take into consideration the particular circumstances on each farm. Many of the factors are personal and the answer depends on the farmer and his family. An installation which is financially sound for one farmer might be a mistake on a neighboring farm. The operator needs to make investments in the projects that will give the most favorable returns, and to select projects which can be carried out with present resources without imposing a debt burden out of line with ability to pay.

A poultryman might wish to consider alternatives such as installing an automatic water system or an automatic feeder, rearranging pens for greater efficiency in gathering eggs and feeding, installing central heating in brooding facilities, increasing flock size, or purchasing new egg-marketing equipment. A dairyman might have alternatives such as rearranging barn facilities to reduce chore time and travel distance in milking, hay or silage feeding, barn cleaning, to buy additional forage harvesting machinery, or to increase herd size or improve herd quality. Whatever the possibilities for improving efficiency seem to be, they should be thoroughly analyzed in terms of additional costs and additional returns. The procedure below may be used as a rough guide to the appraisal of the cost component of such analysis. However, with some of the alternatives such as automatic watering or feeding systems, substantial operating and maintenance costs, in addition to depreciation and interest, must be taken into account.

It may be helpful to operators who are concerned with building bins to review a method for making economic decisions on the basis of additional costs and additional returns. Some of the costs are not out-of-pocket and some of the benefits are personal and intangible.

In estimating additional costs, the operator's time and the labor of regular hired men can be omitted especially if the construction work is done in slack periods and does not interfere with their production in daily work. For example, if the installation involves a cash outlay for materials of \$200, and for skilled carpenter services of \$50, plus 100 hours of available farm labor, the total additional cost might be considered as \$250.

One farmer hired a carpenter to make a complete installation including storage bins and elevator to service 4,000 layers in a two-story house. In this installation the automatic feeders were filled directly from the elevator. The cost was \$472.55 for the bulk handling installation, not including the automatic feeders, which represents an investment of 11.8 cents per layer. The annual cost of this installation will be the sum of the estimated costs of depreciation, interest, other fixed charges, and operating expenses.

The annual depreciation can be estimated by the following formula:

$$\text{Annual depreciation} = \frac{\text{Initial Cost} - \text{Junk Value}}{\text{length of life}}$$

Assuming a length of life of 10 years and a junk value of \$50:

$$\frac{\$472.55 - \$50}{10} = \$42.25 = \text{Annual depreciation}$$

The annual interest charges can be estimated as follows:

$$\text{Annual Interest} = \frac{\text{Cost}}{2} \times \text{rate of interest } (5\%)$$

$$\frac{\$472.55}{2} \times \frac{5}{100} = \$11.81$$

The expected benefits from the installation can also be inventoried and appraised. There may be very apparent benefits such as: discount on bulk delivery, elimination of bag costs, release of usable space in the grain room, or saving of time. Less apparent benefits may be a decrease in the physical burden and more flexibility in the use of labor. The value of these will vary according to the situation on each farm. But having made a rough estimate of the annual charge associated with the cash investment, the operator can ask himself this question. "Will the benefits expected be worth while in view of the annual cost, and in view of the other pressing needs?"

Table 7 summarizes the costs and benefits possible for the particular installation described above.

Table 7. Estimated Annual Costs and Benefits from One Bulk Feed Installation[1]

Costs		Benefits[2]	
Depreciation	$42.25	Decreased feed wastage (less by 1.0-5.8 pounds/ton)	$ 10.37- 60.06
Interest	11.81	Elimination of bag loss (low and average rates in Table 6)	8.74- 38.89
Taxes, insurance, maintenance	5.60	Time savings in feeding (.1-.3 man minutes daily per 100 layers at $1/hour)	24.33- 73.00
Operating expense	30.00	Savings on purchase price of feed ($1-3 per ton)	218.40-655.20
		Additional net income from 288 birds in released space[3]	
		Effects on the labor force	

[1] For 4,000 layers, described in text.

[2] Some of these items are "potential" benefits until put to productive use, i.e., time savings and released space.

[3] Space released assumed to equal 2 grain rooms 24′ by 24′. Should take into account costs involved.

One man may decide on the basis of having considered alternatives, that an increase in flock or herd size should be given priority. Another man may decide that permanent bins will be most profitable. In making a final decisions, it may not always be the dollars-and-cents differences between direct costs and returns which will provide the answer.

Effects on the Labor Force.

Reference was made in the preceding section to less apparent benefits from conversion to bulk feed such as a decrease in the physical burden and more flexibility in the use of labor. These considerations may be of special significance to older operators and on family farms where there is little or no hired labor. Also, taking some of the heavy work out of farming may enhance its attractiveness to hired workers.

It is difficult to prove that the elimination of lifting and handling several tons of grain in 100-pound bags actually pays in dollars and cents. Some young and vigorous operators may find wrestling with 100-pound bags a diversion and a challenge. On one farm visited the operator and his help considered handling 240 of these weekly no burden, but on another farm the operator, who has to carry only 30 bags a week up a flight of stairs, considered this a real burden and stated he had just about reached his limit for this type of physical effort.

Many farm operators and workers probably should not be handling 100-pound bags; others find it one of the most objectionable features of farm employment. Bulk handling can extend the productive life of older men. In emergencies, children and the farm wife can carry on a large part of the essential work. One poultryman who invested about $500 in elevators and permanent bins stated that the major benefit to him was that the installation made it easy for members of his family to take over certain chores in an emergency. In another case, a more expensive installation in a four-story house made grain-feeding more or less completely automatic and enabled the wife to do the daily chores in caring for 3,000 layers whenever the husband could use his time to advantage on other tasks. A poultry house with 8,000 layers will require about 8 tons or 160 bags a week. This often means lifting these bags, carrying them, opening, relifting, and emptying in the process of feeding. On some farms this has been entirely eliminated.

3. Efficiency of the Grain Feeding Operation on Poultry Farms

SOME measures of changes in labor and capital requirements in poultry production during the last two decades, as indicated by results of selected studies, are presented in Table 8. The differences between the 1929 and 1953 figures reflect in large part efficiencies resulting from current use of larger laying pens and more extensive practices in brooding and rearing. To some extent they also involve a higher degree of mechanization and simplification of chore practices. Included in the gains in efficiency in the last two decades have been some relating specifically to grain feeding.

Table 8. Chore Labor Time and Investment in Buildings and Equipment, 1929 and 1953 New Hampshire Poultry Farms

	1929	1953
Annual man hours per 1,000 layers for chores	2,404[1]	529[2]
Investment in buildings and equipment per 1,000 layers	$7,680[3]	$5,854[4]
Hours of chore labor to raise 100 pullets to laying age	78[5]	7.3[6]

[1] H. C. Woodworth and F. D. Reed, *Economic Study of New Hampshire Poultry Farms*, N. H. Agr. Exp. Sta. Bul. 265, p. 16. May, 1932.
[2] E. H. Piper, *Chore Practices on New Hampshire Commerical Poultry Farms*, N. H. Agr. Exp. Sta. Circ. 73, p. 3. June, 1946. Average daily chore time per 1,000 layers — 87 minutes.
[3] N. H. Agr. Exp. Sta. Bul. 265, p. 8. Depreciation charges for laying houses, converted barns, and equipment converted to 1953 prices.
[4] G. E. Frick and W. K. Burkett, *Farm Management Reference Manual*, N. H. Ext. Circ. 307, p. 32. Sept., 1953. Cost of 3-story 36′ x 36′ house, plus estimated costs of feeders, nests, automatic water system, wiring and fixtures.
[5] N. H. Agr. Exp. Sta. Bul. 265, p. 18.
[6] E. C. Perry, *Chore Practices on New Hampshire Commercial Poultry Farms. II. Pullet Replacements.* N. H. Agr. Exp. Sta. Circ. 79, p. 12. April, 1949. Time per 1,000 chicks started; brooding, 37.5 hours for 12 weeks; 35.0 hours per 1,000 birds ranged, for 10 weeks.

Grain-feeding is one of the important components of total chore time on poultry farms. Other important chore jobs include, for rearing, watering, caring for heating equipment, and for laying flocks, watering, gathering eggs. The relative importance of the grain-feeding operation in relation to total chore time with laying flocks and in replacement rearing is illustrated in Table 9. These data are averages obtained under specific conditions, but they are indicative of the significance of feeding time in any study of measures to improve chore efficiency.

Unit Size and Specialization.

Increasing specialization in poultry production has been accompanied by a decrease in numbers of farms (Table 10). Meanwhile the total production of poultry and eggs has increased; consequently, production per farm has increased substantially. The increases in individual farm output have also been due in part to progress in breeding, feeding, and management which resulted in faster growth of meat birds (enabling more lots to be handled per year) and higher egg production per layer.

Table 9. Relationship Between Total Chore Time and Feeding Time, Laying Flocks and Replacement Rearing.

Enterprise	Total Chore Time (Man mins. per day)	Chore Time in Feeding (Man mins. per day)	Percent Feeding of Total Chore Time
Laying flocks	87.0[1] (man hours)	27.0[2] (man hours)	31
Brooding, 12 weeks	37.5[3]	13.2[4]-19.9[5]	35[4]-53[5]
Range rearing, 10 weeks	35.0[3]	7.0[6]-10.5[7]	20[6]-30[7]

[1] N. H. Sta. Cir. 73, p. 1.
[2] Table 14. For multiple story houses with systematically located grain room on each floor and feed carried into pens in pails.
[3] N. H. Sta. Cir. 79, p. 12.
[4] *Ibid.*, p. 6. Mash only, 9.4 minutes/day/1,000.
[5] *Ibid.*, p. 6. Mash and scratch, 14.2 minutes/day/1,000.
[6] *Ibid.*, p. 12. Mash or pellets in hoppers, 10 minutes/day/1,000.
[7] *Ibid.*, p. 12. Scratch fed in addition, 15 minutes/day/1,000.

Table 10. Numbers of Farms Engaged in Poultry Production, Output per Farm and per Animal Unit, New Hampshire, 1929, 1939, 1949

Item	1929	1939	1949
Chickens on hand[1]			
Number of farms reporting	10,451	8,261	6,596
" per farm "	87.5	165.0	301.3
Chickens sold			
Number of farms reporting	5,557	4.082	3,829
" per farm "	302.3	698.1	1,258.5
Chicken eggs sold			
Number of farms reporting	7,467	7,767[2]	4,279
Dozens per farm "	928	1,869[2]	5,346
Eggs sold (dozen) per chickens on hand	7.6	10.6[2]	11.5

Source: Census of Agriculture, 1950

[1] Chickens on hand, 4 months old and over, April 1 of year following.
[2] Produced. Hence, larger number of farms than for 1929 because farms producing solely for home consumption included. Also relatively higher numbers per farm and egg output per farm in relation to 1929 and 1949 than comparable series would show.

In terms of the proportions of New Hampshire's output of eggs and poultry, the share of the output accounted for by larger units has increased tremendously in the last two decades. These data are shown in Table 11. From 1940 to 1950 the proportions of chickens on hand April 1, 4 months old and over (a fair measure of laying flocks), and eggs produced by flocks of 3,200 and over doubled. The proportion of chickens sold (including some broilers as well as fowl) from units of 3,200 and over (on hand) increased even more. The trend toward larger units has continued since 1949-50, probably at an accelerated rate.

Table 11. Percent of Output of Eggs and Poultry Accounted for by Different Flock Sizes, New Hampshire, 1929-1950

Item	Year	Under 100	100-399	400-799	800-1,599	1,600-3,199	3,200 and over	400-699	700-999	1,000-2,499	2,500 and over
Chickens on hand Apr. 1	1930	28.9	32.0	—	—	—	—	13.4	7.4	12.6	5.7
	1940	12.1	18.8	19.7	22.2	13.5	13.6	15.5	11.0	24.8	17.8
	1950	6.0	10.5	16.3	22.2	19.0	26.0	—	—	—	—
Chicken eggs produced	1929	29.5	31.5	—	—	—	—	13.4	7.3	12.9	5.4
	1939	11.4	18.9	21.7	22.6	12.3	13.1	17.0	11.3	24.8	16.6
[1]	1949	4.6	9.2	17.5	26.3	16.1	26.3	—	—	—	—
Chickens sold	1929	19.4	33.2	—	—	—	—	14.9	9.8	16.0	6.7
	1939	10.6	18.7	20.8	22.8	12.3	14.8	16.5	11.5	23.6	19.1
	1949	6.5	9.7	12.7	20.8	18.2	32.1	—	—	—	—

Source: Census of Agriculture, 1940 and 1950.

[1] Chicken eggs sold. Overstates the importance of larger sizes only slightly.

Contributing to increased specialization (and unit size) have been the adoption of mass housing and other practices productive of efficiencies in the use of capital and labor. Viewed in terms of a constant price level, total investment per farm has increased, but over a long period it is not clear that this is true of average investment per bird. On the other hand, labor input per bird has significantly decreased. Coupling these changes with improved output per unit of input of other elements entering into production has resulted in relative decreases in per unit costs. This has enabled the industry to improve its position in the market relative to other livestock products through larger production and lower prices.

A study of poultry accounts from 1931 to 1945 on New Hampshire flocks of under 3,000 laying hens indicated an upward movement in labor incomes over the period.* This was particularly noticeable during the war years. The study concludes that while there was an increase in labor incomes for poultrymen, purchasing power of that income did not increase proportionately. Thus, to maintain a parity of purchasing power with other groups, poultrymen would have had to increase unit size. The tightening of both actual and relative per unit income has been more apparent in the poultry-meat category since the early postwar period than on eggs, where a modified cyclical effect has occurred. Nevertheless, in both areas, 1954 saw the most severe conditions since World War II.

The stage is thus set for further concentration of commercial output in larger units, only temporary setbacks in the upward trend in aggregate output, increased specialization, and adoption of more efficient practices (within the limits of financing). It is against this background that the reader is asked to view the discussion of the grain-feeding operation and how its efficiency can be improved.

Present plant size and degree of specialization are directly related, exclusive of some variations in the financial position of particular individuals in like size class, to the ability of the business to defray improvement costs designed to make the unit more efficient. Based upon an analysis of

* Abell, M. F., *Economic Analysis of Fourteen Years of Poultry Records*, N. H. Agr. Exp. Sta. Circ. 75, June 1947, p. 3.

additional costs and savings, it is likely that mechanization can be carried further with the larger and more specialized enterprises.

Pen Arrangement, Size, and Seqence.

Rearrangement of equipment within pens can frequently yield potential time savings. A relatively small amount of labor need be invested, but unless the proper re-alignment of equipment is devised, time savings may be small. This indicates the need for considerable advance planning before rearranging equipment within pens.

However, with respect to pen size, it is somewhat easier to demonstrate labor savings with large pens instead of small ones. Reductions in feeding time and travel distance by removing partitions to enlarge pens were observed in a Pennsylvania study.* Most new construction of commercial poultry units in New Hampshire incorporates large pens. Table 12 presents some examples of the effect of pen size upon man minutes required daily to feed 100 layers.

Table 12. Influence of Laying Pen Size on Labor Efficiency in Feeding, 4 New Hampshire Farms

	Feed System	Feed to Pen by:	No. Pens	No. Birds	No. Birds per Pen	Man Minutes Daily per 100 Birds
Farm A	Mash-scratch	Hand	3	1,300	433	1.92
	" "	"	3	5,500	1,833	1.09
Farm B	" "	"	4	800	200	3.75
	" "	"	7	2,600	371	2.69
	" "	"	6	3,600	600	2.22
Farm C	Mash-scratch-pellets	"	9	1,600	177	3.12
	Mash-scratch-pellets	"	2	1,000	500	2.50
Farm D	All-mash	Carrier	27	4,860	180	1.34
	" "	"	10	6,000	600	1.25

Because of a limited amount of data suitable for classification, it was impossible in this study to demonstrate conclusively the effect of number of pens in sequence upon feeding time. However, it is not difficult to diagram the potential savings in travel distance under different conditions. A number of pens in sequence are probably more efficient than a like number of single pens, but as with other factors, there is undoubtedly a point at which the number of pens in sequence becomes so great that efficiency drops sharply. Just what this number is in each case would depend upon the feeding method (all-mash or mash-scratch-pellets) and upon the capacity of means used to transmit feed to pens (hand, carrier, automatic feeder).

The Diverse Nature of Housing and Handling and Feeding Grain.

An appraisal of housing facilities on New Hampshire poultry farms reveals great variability between farms and even on the same farm. There are scattered individual units of small dimensions, remodelled barns, con-

* Bressler, G. O., *Labor Saving on Pennsylvania Poultry Farms,* Penna. Agr. Exp. Sta. Bul. 532, Aug. 1950, pp. 49-50.

tinuous single- and multi-story houses of varying length and depth. These various types of structures are representative of different periods in the development of the state's poultry industry. Today's recommendations for commercial units stress larger numbers of birds per pen, 30-40 foot depths, and forced-draft ventilation. Not too many years ago sentiment was for smaller pens, 20-odd foot depths, and natural-draft ventilation.

With the great variability in types of housing facilities, it follows that methods of handling and feeding grain are diverse. In addition, adjustments in handling and feeding grain are limited by the larger cash outlay necessary with older facilities. This suggests that each farm must be treated as an individual case, and that with older facilities only limited progress can be made to improve operating efficiency.

For purposes of studying facilities and methods of handling and feeding grain, over 50 commercial poultry farms were visited. Many variations in housing facilities and methods of handling and feeding grain were observed. Diagrammed in the following pages are some variations in grain-feeding arrangements, for both bagged (non-bulk) and bulk feed delivered to the farm. Note that some of the non-bulk arrangements are designed for feed received in bags, but handled in bulk to the pens. Some farms have made use of various arrangements and auxiliary equipment to minimize or eliminate lifting and carrying. Likewise, some grain dealers employ auxiliary equipment in making deliveries to farms for the same purpose.

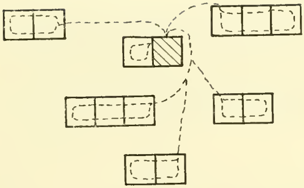
Some farms in the state have used bagged feed and bulk bins with downspouts for many years. However, this is the exception rather than the rule, and extensive use of bulk bins, carriers, conveyors, elevators, and automatic feeders is of rather recent origin. The present interest in improved feed handling methods on the farm was generated during and immediately after World War II with the shortage and high cost of manpower. Narrowing price-cost spreads in recent years have also given impetus to labor-saving steps and to mechanization. These go hand in hand with the development of efficient and larger units.

Non-Mechanized Handling of Bagged Feed.

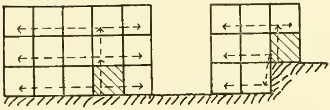
Figure 1 indicates methods of handling bagged feed which have been used many years on New Hampshire poultry farms. Bagged feed is unloaded by hand, stored in bags, and carried to pens in pails or bags. In some of the less-efficient plants feed may be carried from one building to another, upstairs, or downstairs. In other instances grain may be available to the feeder on each floor of a building. Where grain rooms are too numerous, servicing the farm may be extremely inconvenient for the feed dealer, though very convenient for the feeder.

Mechanized Handling of Bagged Feed.

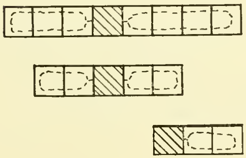
It is quite feasible to adapt some form of mechanization to the handling of bagged feed, either from the standpoint of unloading or in actual feeding. Examples of the former are conveyors and hoists; of the latter, overhead carriers, downspouts, and automatic feeders. There are various modifications which can be made of the examples in Figure 2. For example, downspouts can be combined with overhead carriers or automatic feeders.



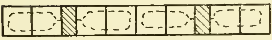
Central grain room with feed carried by attendant, truck, or wheelbarrow to scattered houses.



Grain room on one floor of multi-story house.



Grain room in each single-story house or on each floor of multi-story house.



Grain rooms at a number of convenient points in single or multi-story houses.

Figure 1. Examples of non-mechanized methods of handling bagged feed on poultry farms.

A number of feed companies provide information on methods of improving feed handling practices on the farm. Typical of such with respect to bagged feed is a pamphlet published by a cooperative operating in New Hampshire.* There are also numerous articles in agricultural magazines dealing with methods used and equipment devised by poultrymen throughout the country to mechanize the handling of bagged feed. All such sources should be helpful in finding the method best suited to the individual situation.

Gravity-flow Installations.

Having feed available on most floors by gravity may simplify feeding operations and reduce physical effort. But the problem of elevating feed so that it can be made available by gravity is usually one which concerns both the feed dealer and the farm operator. Some farm operators have requested and obtained second or third floor deliveries of grain-feed for many years. In many instances feed dealers have had to make these difficult

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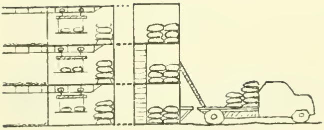
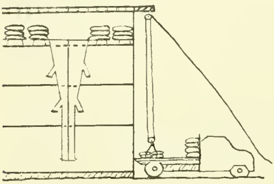
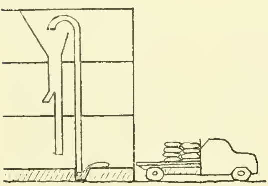
* *Make Feed Handling Easy*, Eastern States Farmers' Exchange. April, 1954.



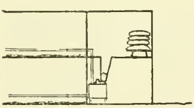
Grain room in each single story house or on each floor of multi-story house, pens serviced by carrier. Conveyor may be used for unloading (either carried on dealer's truck or built into house).



Grain storage in "attic of converted barn. Feed received in bags, raised by rope sling and hay fork mechanism (10 bags at a time), and stored in "attic". Bulk bins filled twice weekly, feed spouted to pens below. An electric hoist could be used in place of the present equipment.



Grain unloaded in bags. Dumped into hopper, elevated vertically and stored in third floor bin. Third floor served by scooping into pails, first and second floor by downspouts.



Grain storage on second floor, downspout to automatic feeder below serving both floors. Grain may be unloaded by hand truck at second floor level or raised by conveyor.

Figure 2. Examples of mechanized methods of handling bagged feed on poultry farms.

deliveries by carrying 100-pound bags up flights of stairs. In others, the farm operator has installed a hoist, elevator, or conveyor; in some cases the feed dealer has carried a portable conveyor on the truck or used a body jack arrangement. Some plants are so located that ramps to various floors can safely be used.

Conversion to bulk feed can effectively solve the problems of elevating feed so that it can be made available by gravity. With the auger-type system the height to which feed can be elevated is limited with present equipment. With the pneumatic-type system greater heights can be reached and also greater horizontal distances can exist between truck setting position and storage bins. These conclusions relate to conditions where no auxiliary equipment is available on the farm, i.e., elevators and horizontal conveyors. With the pneumatic-type system, feed is blown to the desired point through a system of pipes extending from bins to the outside of the building. Ordinary stove pipe is frequently used. Another advantage in bulk delivery lies in the elimination of the handling and emptying of 100-pound bags.

Figures 3 and 4 show some of the simpler ways to utilize gravity flow. These exclude farm installations of elevators and horizontal conveyors. Some of the first arrangements shown can be adapted equally well to bagged or bulk feed; some of the later ones are probably better adapted to bulk unloading.

Installations for Handling Bulk Feed.

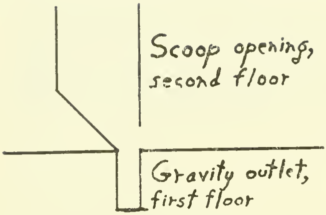
Some diagrams of installations for handling bulk feed are shown in Figures 5 and 6. With smaller units, bulk feed could be handled by gravity flow on one or more floors and scooping or dipping on the top floor. The second stage of complexity might occur where gravity flow is utilized to fill carriers and automatic feeders. These two groups are illustrated in Figures 3 and 4. The installations in Figures 5 and 6 were designed for handling bulk feed unloaded by the auger-type equipment at larger installations, including for the largest plants, elevators and horizontal conveyors. Where the plant is serviced by the pneumatic-type equipment, similar results could be accomplished by a system of pipes between bins and the outside of the building. Feed could thus be blown to desired points without auxiliary equipment on the farm.

A practical point to note in considering delivery by auger-type vs. pneumatic-type is that in the event of breakdowns of delivery equipment, it is not possible to substitute one type for another. The auger-type cannot reach bins at removed points; the pneumatic-type requires a system which is more nearly airtight to prevent feed from being blown out of the storage bins and to prevent dust danger. The choice between the two systems, aside from what the feed dealer may offer as service, may be determined by the presence or absence of serviceable auxiliary equipment in the farm.

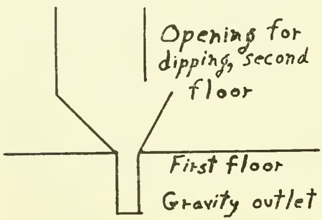
Incorporating Existing Equipment When Shifting to Bulk Feed.

Likewise, in considering conversion from bagged to bulk feed, the farm operator may wish initially to incorporate existing equipment into the new system. Figure 7 shows two examples of the changeover from bagged to bulk feed. In the first example the overhead bulk bin was substituted for the first floor grain room, the carrier then being filled by gravity. Elimination of the first floor grain room released space for other uses. Next, an automatic feeder was installed, and this was so placed that it could be filled by gravity.

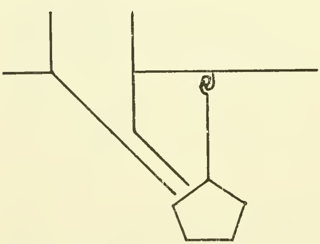
The second existing situation involved a third floor grain room where bags were emptied into bins, with the second and first floor bins filled by gravity. Fourth floor bins were filled by means of a belt elevator from the third floor. This layout could readily be adapted to bulk feed, filling either carriers or automatic feeders by gravity. If third floor bins could be filled directly from the bulk delivery truck, downspouts could service the first and second floors, either using automatic feeders on each floor or one on either floor with a line running to the other floor. The fourth floor could be serviced by retaining the belt elevator or by using automatic feeders on the third floor with lines running up to the fourth floor.



A low cost bin for small houses if grain is not delivered at sufficient height for gravity flow on second floor.

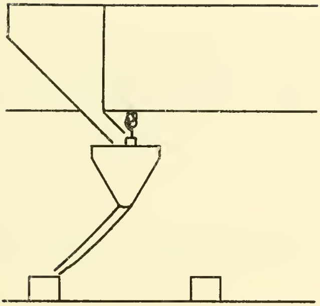


A similar bin to the one above, but designed for dipping out grain on second floor.

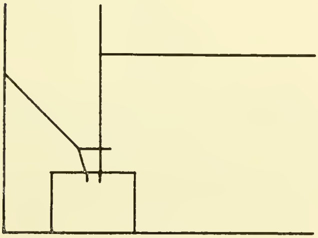


Storage to carrier by gravity. If operator uses a feed carrier, the carrier platform can be converted into a box, and the carrier truck can be relocated in the grain room so that the box can be filled by gravity.

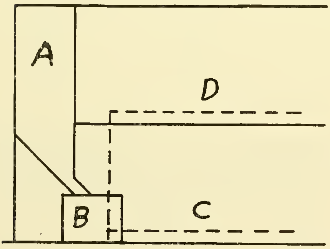
Figure 3. Installations making use of gravity flow.



Storage to high carrier by gravity. Reports from other states indicate that a few operators have built special grain carriers which are suspended from the usual carrier track but as near the ceiling as practical. These are filled by gravity from bins above the grain room. By the use of flexible metal pipe, hoppers within five feet of the track can be filled by gravity. The same equipment could be used to fill small bins in each pen for use in feeding pellets or scratch.

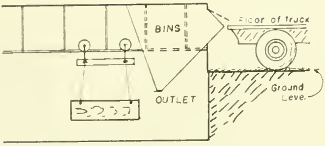


Storage to automatic feeder by gravity.

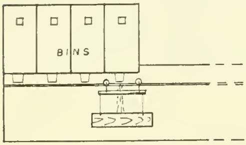


Installation of storage bin and automatic feeder equipped with mechanism to lift feed to upper floors.
A - Storage bin.
B - Automatic feeder.
C - Feed trough, first floor.
D - Feeder lift and trough, second floor.

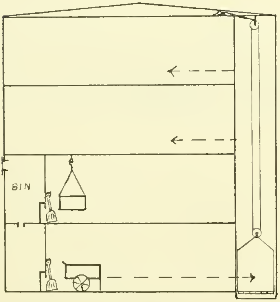
Figure 4. Additional installations making use of gravity flow.



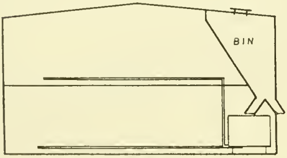
Bin opening at truck floor level. Originally operated with bagged feed, but designed for bulk when available. This is a pole-type, single-story house with end ramp to accommodate truck.



Single-story house with overhead bins. Carrier filled from spout.

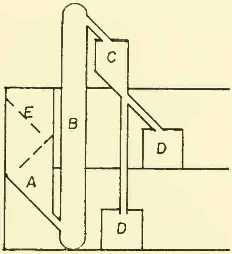


Bulk bin on second floor filled from bulk truck; first floor bin filled by gravity. First and second floors serviced by filling buckets with scoop and pushing carrier. Third and fourth floors serviced by hand cart loaded by scoop and transported by elevator.



Overhead bin, dual spout serves both an automatic feeder for two floors and an outside outlet for filling range cart.

Figure 5. Installations for handling feed in bulk.



Storage bin and elevator.

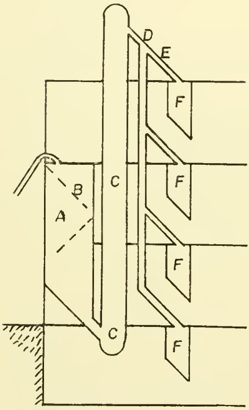
A - Storage bin.

B - Elevator.

C - Small bin.

D - Automatic feeder.

E - Baffle boards to prevent feed separation.



Installation to make feed available on each floor of four-story dairy barn.

A - Side view of storage bins. (three bins in a row.)

B - Baffle boards. (Installed in deep bins to direct the flow of grain, prevent separation and dust.)

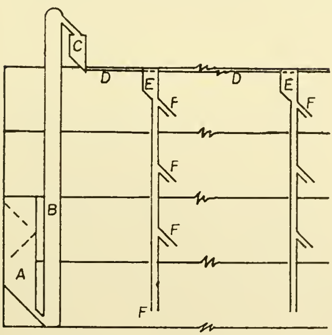
C - Elevator boot filled by gravity from any of these storage bins.

D - Discharge spout.

E - Two down spouts connected to series of small bins on each floor.

F - Small divided bins, one for mash and one for scratch.

By use of a pneumatic-type bulk truck for unloading, and a system of pipes, the same result can be accomplished without the elevator and master storage bins.



Installation to make feed available by gravity flow in each pen in four story house.

A - Storage bins — mash and scratch.

B - Elevator.

C - Small holding bin.

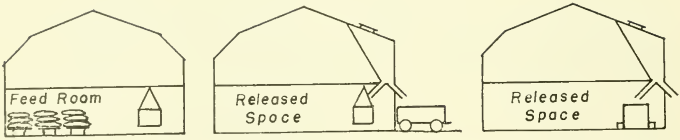
D - Horizontal conveyor.

E - Small bins divided mash and scratch.

F - Down spouts and outlets.

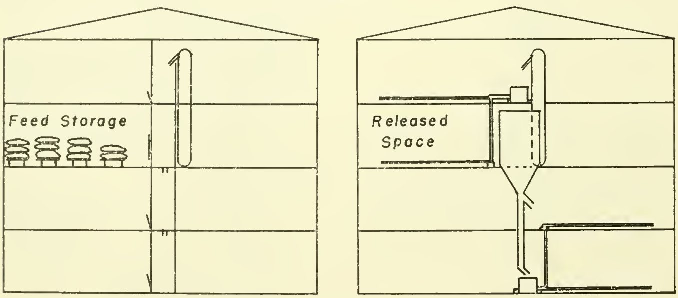
Figure 6. Additional installations for handling feed in bulk.

Example 1



Left: feed room; carrier to pens loaded with bags. Center: bulk bins; carrier to pens; can also load into vehicle outside for range. Right: bulk bins; automatic feeder; can also load into vehicle outside for range.

Example 2



Left: grain unloaded at third floor in bags; emptied into bulk bins. First and second floor bins filled by gravity; fourth floor bins by belt elevator. Grain scooped by hand into buckets and carried to pens. Right: grain unloaded at third floor in bulk. First and second floor serviced by spouts; fourth floor bins by belt elevator. Automatic feeders servicing each floor.

Figure 7. Examples of changing from bagged to bulk feed.

Time Requirements in Feeding Laying Hens.

As one phase of studying methods and facilities on commercial poultry farms, operators were asked to provide data on time requirements in feeding laying hens.

Table 13 contains examples of the effect of unit size on feeding time. Enough records were taken to make estimates for several size intervals for feed carried by hand and by carrier. In most other categories in Table 14, such was not the case. Note that the data in Table 13 are also suggestive of limitations to the decreasing feeding time per 100 birds as flock size increases. With feed being carried into pens in pails, time per 100 birds declines to the 2,101-3,600 interval, then rises. With carriers used, the decline persists into the 3,601-7,000 interval, then rises.

The preceding illustrations of the effect of unit size involve suggestions of diminishing efficiency in labor utilization beyond an optimum point.

Table 13. The Effect of Flock Size on Feeding Efficiency Under Two Methods

Method and Interval (No. of Birds)	Number of Observations	Average No. Birds	Average No. Man Minutes Daily	Man Minutes Daily Per 100 Birds
Feed carried into pens by hand				
1,000 and under	5	764	42	5.50
1,001-2,100	18	1,588	65	4.07
2,101-3,600	7	3,000	93	3.10
3,601-7,000	6	5,683	184	3.24
10,000 and over	1	10,100	360	3.56
All Flocks	37	2,638	94	3.56
Feed into pens by carrier				
1,000 and under	1	750	30	4.00
1,001-2,100	5	1,760	38	2.16
2,101-3,600	7	3,528	74	2.11
3,601-7,000	4	6,227	131	2.11
10,000 and over	1	15,000	360	2.40
All Flocks	18	4,120	90	2.18

Similar conclusions probably also would result from a detailed study of pen size and number of pens in sequence. These considerations again emphasize the unit-by-unit approach to achieving maximum efficiency in the grain-feeding operations. The "best" method for the particular farm, and what degree of mechanization will be used, will be dependent upon size and sequence considerations, feeding methods, individual operator's efficiency and aptitudes, existing farm facilities, and financial position, as well as fixed and operating costs for various combinations. A special time-motion study can be carried out for each individual plant plus a series of financial budgets of various production alternatives in order to uncover optimum organization.

In Table 14 data on time requirements in feeding laying hens are summarized for a number of categories. These data should be regarded as relative rather than absolute since they are not adjusted to comparable unit size, they include various feeding methods, and are derived from operator's estimates rather than actual time studies.

The averages in Table 14 show a progressive decrease in feeding time per 100 layers as grain supplies for the feeder are more systematically located, and as the degree of mechanization increases. From 8.0 man minutes daily per 100 layers, with scattered individual houses, time requirements in feeding declined to 2.7 man minutes with systematically-located grain rooms on each floor of multiple-story houses, but feed carried into pens by hand. A similar setup to the latter, but with pens served by carrier, indicated time requirements in feeding of 2.2 man minutes daily.

Data collected pursuant to preparation of Table 14 do not indicate any compelling reasons why the installation of bulk feed as such will materially decrease feeding time. Actually many time savings can be realized on some farms by rearrangement of facilities for handling grain in bags. Given a good arrangement for handling and feeding grain in bags, the net decrease in feeding time by conversion to bulk feed is likely to be small.

In Table 14, daily time requirements per 100 layers were 2.1 man minutes where bulk feed was available by chute in each large pen, but carried to hoppers by hand. This represents little difference from servicing pens by carrier, or in part by hand, and requires a more elaborate setup than having bulk feed available in the grain room. Bulk feed, however, decreases physical effort, and facilitates the use of certain labor-saving equipment such as elevators and horizontal conveyors on larger farms. It eliminates the necessity for handling 100-pound bags, although filling a given unit by gravity rather than by lifting and dumping bags may save little time. Bulk feed lends itself well to fully-automatic feeding setups. Hence, of more significance to poultrymen than time savings from simpler bulk feed setups are the time savings to be realized by the installation of overhead carriers and automatic feeders. The savings in chore steps made possible by use of a carrier were diagramatically illustrated in Station Circular 73.* In Table 14, there is a savings of 0.5 minutes daily per 100 layers between carrying grain into pens in pails from the grain room and using a carrier in feeding. The data also indicate a possibility of saving an additional 1.7 minutes daily by using an automatic feeder.

Table 14. Man Minutes Required Daily to Feed 100 Layers Under Various Systems

Type of System	Multiple Story Houses	Single Story Houses
1. Central grain room for farm, scattered individual houses served manually from this point	8.0	
2. One grain room per house; feed carried to other floors and into pens in pails	5.6	5.9
3. Grain room on most floors, but some served by spouts and/or carrying; feed carried into pens in pails	3.4	—
4. Grain room on each floor, systematically located; feed carried into pens in pails	2.7	—
5. Grain room on each floor, systematically located; bulk or bagged feed; feed carried to pens on carrier, in bags, and in pails	2.4	—
6. Grain room on each floor, systematically located; pens serviced entirely by carrier	2.2	2.7
7. Pens served by carrier, series of storage barrels in pens filled; feed carried to hoppers in pails	—	2.5
8. Bulk bins in each large pen; feed carried to hoppers in pails	2.1	—
9. Grain located in center each smaller pen; feed carried to hoppers in pails	—	1.2
10. Combinations of bulk and bagged feed, with and without carrier to pens; using automatic feeders for part of feeding	1.6	—
11. Bulk feed; using automatic feeders, mash and scratch	0.5	—
12. Bagged feed stored on second floor; downspout to automatic feeder below; all mash system	0.33	—

* Piper, E. H. *Chore Practices on New Hampshire Commercial Poultry Farms*, N. H. Agr. Exp. Sta., Sta. Circ. 73, June 1946, p. 4.

Comparative data on farms with a grain room on each floor, systematically located, where pens were serviced by carrier show that on one farm of over 10,000 layers only 1.3 man minutes were required daily per 100 birds for feeding. This farm fed an all-mash ration. Several farms with an aggregate of over 22,000 layers that fed combinations of mash and scratch and/or pellets required 2.6 man minutes daily per 100 birds. This is illustrative of the possibilities of increased labor efficiency through simplification of the feeding program, but in no sense a judgement on the relative output per bird which might be obtained. With automatic feeders, some operators continue to hand feed scratch or pellets; others utilize attachments in the automatic system for supplying these supplementary items to the flock. In either case, some decrease in operator's time and/or operating time for equipment is likely as the program is simplified.

Variation in the efficiency of different individuals is rather strikingly illustrated by two farms. Both had a number of small grain rooms, conveniently located to minimize travel distance for the feeder. On one farm with over 2,000 layers, feed was carried into pens in pails and feeding required 2.7 man minutes daily per 100 layers. On the other, with over 10,000 layers, workers carried 100-pound bags and filled hoppers directly from these; here, only 1.4 man minutes daily were required per 100 layers. Although part of the difference can be attributed to the respective unit sizes, most of the remaining difference can be explained by the increased travel time in carrying pails as against 100-pound bags and to the elimination of emptying bags into bins or pails. Achievement of feeding efficiency by such means is dependent upon the ability and willingness of farm workers to undertake the rather arduous physical effort required. Some degree of mechanization is probably a more acceptable solution on most farms.

The farm where feeding took 1.4 man minutes daily per 100 layers is also illustrative of a considerable amount of chore work cheaply performed by the feed company in making grain deliveries. Grain had to be delivered to almost 20 separate places, almost half of which required throwing 100-pound bags up to the second story in unloading. This obviously made it convenient for the feeder, but a difficult plant for the dealer to service. In contrast to this plant, another farm with 9,000 birds housed in one building had 3 grain rooms all accessible by ramps. Ramps are at times hazardous, and as a result some feed companies are cautious about them. However, if they are properly designed, this need not be a problem.

Due to the varying nature of existing farm facilities, as well as to the present "competitive situation" (prevailing dealer policies), the feed dealer must be somewhat flexible as regards making grain deliveries. Thus, while the individual farm operator would benefit from having deluxe service in placing his grain precisely where he wants it, that benefit is put at the expense of other operators whose plants require less of such servicing. Such situations, whether by circumstances or design, certainly contribute to maintaining an excessive cost of distribution.

An Appraisal of Several Feeding Arrangements.

Basically, feeding arrangements can be grouped under four categories:

(1) Feed carried to pens and hoppers by hand.
(2) Feed available in pens, but carried to hoppers by hand.
(3) Feed brought to pens by carrier, hoppers filled by hand or gravity.
(4) Automatic feeders.

Under each of the four preceding categories, either bulk or bagged feed may be involved. Subsequent discussions and appraisals will not specify between these.

Under category (2) above, a number of examples can be observed in Figures 1-4, and some variations of this category are shown in Table 14. There is still another variation of this category used to some extent in the Middle Atlantic region, but very little, if at all, in New England. This involves floor-feed boxes filled from feed chutes directly above. A Pennsylvania study reported this arrangement required less time and travel distance than filling conventional feed hoppers.* Floor-feed boxes have not found favor with New Hampshire poultrymen, nor have they been widely tested under local conditions.

The problem with servicing individual pens by feed chutes seems to be to fill bins and chutes by an efficient method. Time consumed in filling by hand is likely to offset any savings in feeding time in the pens. However, filling these supply lines can be accomplished expeditiously by elevator, conveyor, or bulk delivery unit.

Another arrangement, which transcends categories (1-3) to some extent, is the use of hoppers of large size. These might effect a saving in labor over smaller hoppers holding but a day's supply. Practical objections to large hoppers include the added attention to prevent clogging of mash, and the idea that it may not be good management to allow birds to pick over a quantity of feed, leaving a residue in the bottom of the hopper which can be refused.† Large hoppers, holding several days' supply, are also not adaptable to limited feeding programs which are in widespread use.

Debate still continues on the pros and cons of automatic feeders. Many of the opponents contend that hopper feeding affords the feeder the opportunity to observe the birds more closely. It would seem more logical to take advantage of labor-saving equipment and to set aside a portion of the time so saved for unencumbered observation at regular intervals. Up to a point combining various chores results in increased efficiency. For example, many operations combine feeding with egg collection. However, too many operations on a trip into the pens may actually impede efficiency.

That there are labor-savings inherent in the use of automatic feeders is apparent from Table 14, as well as from other studies. A Cornell study on broiler production yielded the data in Table 15.‡

Table 15. Relationship Between Type of Feeders Used and Labor Efficiency in Growing Broilers, New York State, 1951-1952

Item	Type of Feeders Used	
	Automatic	Other
Number of lots	17	17
Number started per lot	8,405	9,982
Minutes of labor per bird:		
Feed, water, and care	1.6	3.4
Total	2.2	4.4

* Bressler, G. O., *op. cit.*, pp. 49-50.

† Klein, G. T., *Saving Labor on Poultry Farms*, N. H. Ext. Circ. 283, July 1947, p. 8.

‡ Briggs, G. W., *Broiler Production in New York State*, 1951-52, Cornell Agr. Exp. Sta. A. E. 846, Feb., 1953, Table 15, p. 14.

On a farm in Pennsylvania it was observed that the installation of a mechanical feeder resulted in the saving of 9 minutes daily per 1,000 layers as compared to hand feeding.† However, in a pen of 800 layers, this move was barely profitable when costs of installation and operation were also considered. On the same farm, when a feed carrier was installed, almost 6 minutes daily per 1,000 layers were saved as compared to hand feeding. However, estimated time savings for a 10-year period were insufficient to offset costs in a 24 x 110 foot house.‡

The introduction of costs of installation and operation in comparison to time savings is a necessary step toward appraisal of data such as that in Table 14. Accordingly, there are presented in Table 16 estimates of the annual costs of feeding 1,000 and 3,000 layers under three methods. These involve categories 1, 3, and 4, i.e., feed carried to pens and hoppers by hand; feed brought to pens by carrier with hoppers filled by hand; and, automatic feeding. Data used in making cost estimates are only approximate, and for purposes of illustrating an analytical method. Labor cost estimates are projections of systems 4, 6, and 11 from Table 14.

Basic to any attachment of value to time savings is the supposition that any time saved will be put to productive use or reflected in a reduction in costs of hired labor. Examining the estimates in Table 16 within this framework, it is apparent that the "cost" of chore feeding per 1,000 layers is similar with all options. Hence, mechanization of the feeding operation might not be the best use to make of added capital. However, at the 3,000-bird level, net advantages appear with the mechanization, and added capital appears warranted.

There is a further consideration into which the preceding appraisal does not delve. If the time saved can be put to productive use in enlarging an enterprise, or in adding other enterprises, then mechanization might be considered with the smaller number of birds as well as with the larger number.

Time Savings in Replacement Rearing.

That there has probably been an increase in efficiency in rearing replacement stock is suggested by comparing results from two studies. In 1929 it was found that 78 hours of chore work were required per 100 pullets raised.* Number raised per farm surveyed was less than 1,700. In 1949 it was estimated that rearing a new laying flock and including the time required to house pullets and cockerels took about 140 man hours per 1,000 chicks started.† Here, pullets ranged per farm averaged in excess of 3,500.

Some factors in the increased labor efficiency, aside from increased unit size, have been the shift from colony to continuous brooder houses, the adoption of automatic or central heating in the brooding period, and the utilization of automatic waterers. Emphasis on the preceding, as well as on the adoption of automatic feeders, has probably been more marked in meat-production enterprises than in raising laying flock replacements.

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† Bressler, G. O., *op. cit.*, pp. 21, 50.

‡ *Ibid.*, pp. 16, 50.

* Woodworth, H. C., and F. D. Reed, *Economic Study of New Hampshire Poultry Farms*, N. H. Agr. Exp. Sta. Bul. 265, p. 16, May, 1932.

† Perry, E. C., *Chore Practices on New Hampshire Commercial Poultry Farms, II. Pullet Replacements.* N. H. Agr. Exp. Sta. Bul. 79, pp. 3 and 13. April, 1949.

Table 16. Estimated Annual Costs of Chore Feeding per 1,000 and 3,000 Layers under Three Methods

Item of Cost	1,000 Layers			3,000 Layers		
	Hand	Carrier	Automatic Feeder	Hand	Carrier	Automatic Feeder
Equipment depreciation	30.00	48.00	70.00	90.00	111.50	120.00
Interest, insurance, taxes	7.42	11.88	17.32	22.27	27.59	29.70
Repairs and maintenance	3.00	7.20	14.00	9.00	16.72	24.00
Operating-equipment costs	—	—	70.00	—	—	120.00
Sub-total	40.42	67.08	171.32	121.27	155.81	293.70
Labor cost in feeding[1]	164.25	133.83	30.42	492.75	401.50	91.25
Totals	204.67	200.91	201.74	614.02	557.31	384.95

[1] Hours at $1. per hour.

Many of the modifications possible in feeding laying flocks can be applied equally well to replacement rearing or growing meat chickens in continuous housing. Admittedly, there are variations of details, and since the data obtained did not specifically relate to the brooding period or to meat enterprises, these are not elaborated upon herein. However, data were obtained relative to feeding methods followed in growing replacement stock on range.

The development of new procedures for handling grain for birds on range has not kept pace with innovations designed for house feeding. Of 20 growers interviewed, only 3 were using bulk storage bins. All but 2 were feeding at least mash in hoppers. Five stored grain in buildings, bins, or barrels on the range itself; 3 were trucking direct from the mill or the grain dealer's truck to their ranges. The 2 growers not using range hoppers were drawing pellets and scratch from bulk bins and scattering them on the range from a truck or lime spreader.

Two possible economies of time appear from the data collected, i.e., less frequent feeding and elimination of hoppers (Table 17). On the average, filling hoppers once or twice per week was less time consuming than daily filling. One grower who filled hoppers twice a week, but permitted his birds free choice of mash or scratch in hoppers in the proportion of 2:1, required the lowest number of man minutes daily in feeding per 100 birds in the sample of 20. Both less frequent feeding and elimination of hoppers

Table 17. Man Minutes Required Daily to Feed 100 Pullets on Range

Type of System	Man Minutes/Day per 100 Pullets
Daily feeding, at least mash in hoppers	1.61
Daily feeding, pellets and scratch drawn from bulk bin and scattered from truck or lime spreader, no hoppers	1.00
Less-than-daily filling of hoppers, at least mash in hoppers	.74

are likely to be controversial issues since some will contend they practice daily hopper feeding because it gives more flexibility, better growth, and less wastage of feed.

As was found true in house feeding, there are two additional possible economies in handling grain for range feeding, i.e., simplification of the feeding program and elimination of one or more handlings of bagged grain. The former is also likely to be controversial as regards results. The effectiveness of the latter admittedly rests upon the supposition of proper layout. Diagrammed in Figure 8 are the handlings under various alternatives.

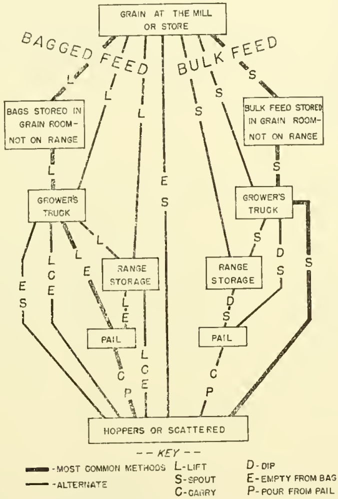
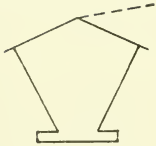


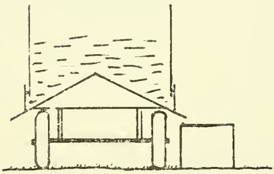
Figure 8. Alternative steps in range feeding.

Full use of the most direct means of handling is not being made with either bagged or bulk feed. Neither are the prevailing methods the most indirect. Delivery by the grain dealer direct to range hoppers or to range storage would seem to offer possibilities of time savings to growers. With the latter, it would probably not be generally inconvenient to the dealer. Also, there is the general objection of the possibility of spreading disease from one range to another.

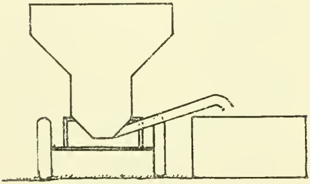
Some methods of saving labor in feeding replacement stock on range are shown in Figure 9. These are all in use in this or other areas.



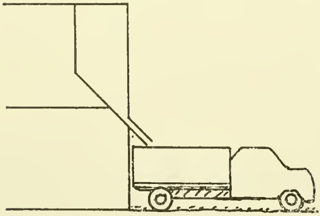
Large capacity range feeder holding several days' or a week's supply.



Range hoppers can be filled by gravity flow from a home made trailer.



For large flocks of pullets or turkeys on range. Commercial equipment is available for conveying feed from trailer to large hoppers. Power take-off from small tractor is used.



Installation of storage bin so that gravity flow can be used in supplying feed to the range. A portable bin near the range may be best for some large ranges. Gravity flow can eliminate one handling and possibly two.

Figure 9. Time-saving management programs to consider in range feeding.

4. Efficiency of the Grain-Feeding Operation on Dairy Farms

MANY dairymen over the years have made substantial improvements in operating efficiency,* through improved buildings and building arrangements, crop production and harvesting adjustments, disease control, breeding programs, and improved chore practices.† As with the New Hampshire poultry industry, numbers of farms engaged in dairying have declined materially over the past two decades. There were milk cows on 11,018 farms in 1930, 10,572 farms in 1940, and 7,603 farms in 1950. Average herd size increased over 25 percent from 1930 to 1950; milk production per cow was up over 20 percent.

Table 18 shows the growing importance of larger units. In 1939, 29.9 percent of farms reporting milk cows had 10 cows or over, and herds of 10 cows or over accounted for 63.0 percent of the total number of milk cows. In 1950, these proportions were 22.3 percent and 75.8 percent, respectively.

Table 18. Shifts in Percentage Distribution of Farms and Milk Cows, by Herd Size, New Hampshire, 1939-1950

No. of Milk Cows	Percent of Farms Reporting			Percent of Cows		
	1950	1944	1939	1950	1944	1939
1- 2	45.9	50.4	45.5	7.8	10.2	10.1
3- 4	9.6	10.1	14.4	4.1	5.0	7.8
5- 9	14.6	14.8	17.8	12.3	14.8	19.1
10-19	19.2	15.1	15.9	33.6	30.4	33.4
20-29	5.9	7.1	4.3	17.2	24.4	15.6
30 and over	4.8	2.5	2.1	25.0	15.2	14.0

Source: Census of Agriculture, 1940, 1945, 1950.

Output per man has increased on dairy farms. At the same time, adoption of new practices and machinery have increased capital requirements. Any attempts to mechanize grain feeding will add to capital requirements and should decrease labor requirements, but the net result on the farmer's income can only be determined by balancing one against the other.

There is probably less time-savings incentive for dairy farmers to rearrange or relocate facilities for storing grain, to adopt bulk feed, or to improve feeding arrangements than there is for poultrymen. Feeding grain to dairy cattle in itself does not take a very significant share of total chore time. In Table 19, for example, only 7 minutes daily are devoted to grain preparation and feeding of the milking herd. Total feeding takes 46 minutes, and total daily chores on cows 360 minutes. An additional 71 minutes are listed for caring for young stock and calves (51) and spreading manure.

* Relative to cost reduction opportunities see Fellows, I. F.; Frick, G. E.; and Weeks, S. B., *Production Efficiency on New England Dairy Farms. 1. A Preliminary Appraisal of Cost Reduction Opportunities.* Storrs Agr. Exp. Sta. Bul. 283, Jan., 1952.

† Feeding, manure disposal, and milking. An example of possibilities under the latter may be found in the following publication: Woodworth, H. C.; Morrow, K. S.; and Holmes, J. C., *Efficient Dairy Chore Practices. Part II. Rapid Milking.* N. H. Agr. Exp. Sta. Circ. 76, June, 1947.

Table 19. Summary Estimates on Man Minutes to do Daily Chore Tasks During Winter Period for 40-Cow Farm (35 Cows Milking)[1]

Daily Chore Task[2]	Man Minutes Daily	
Milking		
Milking	175	
Care of milk	5	
Equipment	45	225
Feeding		
Hay preparation	10	
Hay feeding	10	
Silage preparation	10	
Silage feeding	5	
Grain preparation	1	
Grain feeding	6	
Push feed to cows	2	
Sweep manger	2	46
Cleaning		
Manure disposal	40	
Hoe to gutter	4	
Sweep alleyway	2	
Bedding preparation	2	
Bedding	5	
Superphosphate	1	54
Miscellaneous		
Cows in and out	15	
Currying	20	35
Total daily chore work on cows		360
Other		
Time for spreading manure	20	
Time on small calves	16	
Young stock	35	71
		431

[1] Woodworth, H. C. and Morrow, K. S. *Efficiency in the Dairy Barn*, N. H. Agr. Exp. Sta. Bul. 387, June, 1951, Table 1, p. 51.

[2] Estimates do not include occasional chores.

The preceding values are derived for very efficient conditions, and may understate observed times on many operating farms. In any event, the transition to relatively efficient grain feeding will yield small time savings. For example, one farmer, with 25 cows, has an overhead bulk bin from which he fills his feed cart. Grain feeding takes him 10 minutes per day. Formerly, when he had to carry bagged grain downstairs to fill the cart, it took about twice as long. However, the relatively small net savings of time may still be a profitable one under some circumstances. Any additional investment in building materials, equipment, or labor must therefore be weighed against the value of time saved in feeding, and, if the shift involves a change to bulk feed, possibly take into account the savings in cost of feed. In the preceding example, time savings at $1 per hour, would amount to $60.83 annually. At 1930 lbs. of grain per cow and a net savings of $3 per ton, the savings in cost of feed would be $72.37* Between the two savings, the farmer can obviously pay for the cost of his bulk bins within

* Not adjusted for savings of damage to grain bags when under bagged system.

a year or so. Thus, under some circumstances rearrangements in grain receiving, storing, and handling may prove quite profitable. However, such rearrangements may frequently be delayed because of other time-saving projects. But the farmer should weigh relative costs and sayings of various changes. He may find that rather simple and inexpensive changes on grain facilities often yield a higher rate of return than more elaborate and costly moves.

Moreover, chore time on a dairy farm is a period when the requirements on workers' time are especially critical. Hence, any reduction in grain feeding time may be enhanced since it occurs during the critical time periods.

Improving Efficiency Through Location and Rearrangement.

The locational aspects of the rearrangement of facilities for receiving, storing, and feeding grain on dairy farms must be made in consideration of future rearrangements of facilities for feeding hay and silage, cleaning, milking, handling milk, and the storage of bedding. Hence, a detailed presentation on the relative merits of alternative locations of grain facilities would immediately involve us with all the other phases in the larger issue of maximizing efficiency in the dairy barn. There are a number of recent appraisals directed toward this goal under New Hampshire conditions.*

An earlier study illustrates that the optimum barn arrangement from standpoints of grain room location and travel distance may coincide with total minimum travel distance for a number of chores.† For example, in a 40-cow barn where there was no center alley, and cows faced out, travel distance in grain feeding was 450 feet where the grain room was located in the end, side end, or side middle. When cows faced in, and the grain room was located in the end, travel distance was 324 feet. However, aggregate travel distance for grain feeding plus travel to and from milkhouse, silo, superphosphate storage, bedding storage, and manure disposal was 5,879 feet in the former situation and 6,598 in the latter. In the same example, the net increase in travel distance resulted from an increase in milkhouse travel, while there were decreases for all other components.

No data are available to indicate accurately the time savings which may exist in grain-feeding in a milking parlor vs. stanchion stable. The former is much less common to New Hampshire than to some other areas, though there is much to recommend the pen-stable-milking parlor combination. In terms of new construction, building costs are slightly less with pen stables that incorporate the best present ideas than with stanchion stables.‡ In small herds with pen stables more total-chore labor may be required per cow.§ However, studies in other areas suggest there is a small net labor

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* Woodworth, H. C., and K. S. Morrow, Efficiency in the Dairy Barn, *op. cit.*
Abell, M. F., Labor-Saving Barns, N. H. Coop. Ext. Service, Ext. Bul. 121 April, 1954.
Abell, M. F., Stabling and Milking Arrangements (unpublished).

† Holmes, J. C., *Efficiency Dairy Chore Practices, Part 1, Chore Travel in Dairy Barns*, N. H. Agr. Exp. Sta. Circ. 72, June, 1946, p. 9.

‡ Abell, M. F., *op. cit.*, p. 9.

§ *Ibid*, p. 7.

savings with a well-arranged pen stable.‡ For grain feeding, it appears possible to secure comparable efficiency with either a pen stable or stanchion stable setup, if both are properly designed and management is good.

There are a number of general observations about the location of grain facilities which can be made. These should be considered as an integral part of the entire program of maximizing effiiciency in the dairy barn, depending upon present facilities and methods, and whether the basic layout involves a stanchion or pen stable. Some of these are:

(1) Keep grain in one place. For example, if the present setup involves storage of grain in bags at one point, and filling grain bins at another point (from which point grain feeding begins), locate all grain at an optimum place and eliminate one handling.

(2) Investigate overhead-grain storage where there are space or arrangement problems at the stable level. Use of this method suggests the feasibility of a downspout from a bin which can be filled by bulk delivery equipment or from bags at the convenience of farm workers. When a pen-stable-milking parlor arrangement is involved, there may be merit in storing grain away from the moist conditions of the milking parlor.

(3) Take advantage of the "work center" approach in order to minimize travel distance.* With stanchion stables, grain outlets should logically be in the "feeding work center". With pen stables and a milking parlor, grain outlets and feeding equipment may be in the "milking work center".

A fourth consideration, which appears initially to be of most significance and benefit to the grain dealer, but which in the final analysis bears upon the cost of grain, is that of the location and accessibility of the farm receiving and storage facilities. These should be planned and located to permit efficient delivery. Generally this would mean locating grain receiving and storage facilities against or near an outside wall bordering an all-weather driveway.

The Nature of Facilities for Receiving, Storing, and Handling Grain.

To provide a background on present practices in New Hampshire, methods of receiving, storing, and handling grain were observed on 53 dairy farms. Frequency of delivery of grain to the farm was recorded in 44 cases; of these 17 received grain once per week, 19 every 2 weeks, one once per month and 7 at somewhat irregular periods.

As can be noted from Table 20, grain was most frequently stored in the feed alley or in front of the cows. A smaller number had stable grain rooms. Seven farms had overhead-bulk bins with spouts to the stable, and 5 had overhead grain rooms for bagged feed. About three-fifths of the farms fed grain from feed carts, the remainder from buckets.

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‡ Van Arsdall, R. M.; Ibach, D. B.; and Cleaver, T., *Economic and Functional Characteristics of Farm Dairy Buildings*, Ill. Agr. Exp. Sta. in Cooperation with U.S.D.A., Bul. 570, Nov., 1953.

Byers, G. B., *Effect of Work Methods and Building Design on Building Costs and Labor Efficiency for Dairy Chores*, Ky. Agr. Exp. Sta., Bul. 589, June, 1952.

Brown, L. H., *A Comparative Analysis of Stanchion and Milking Parlor Barns*, Work Simplification News Letter, Purdue Work Simplification Lab., Issue No. 19, June, 1948.

Brown, L. H.; Cargill, D. F.; and Bookhout, B. R., *Pen-Type Dairy Barns*, Mich. Agr. Exp. Sta., Spec. Bul. 363, June, 1950.

* Woodworth, H. C., and Morrow, K. S., *op. cit.*, pp. 10-14

Table 20. Methods of Storing and Feeding Grain on Selected Dairy Farms

Storing		Feeding	
Method	No. of Farms	Method	No. of Farms
Overhead-bulk bins	7	Feed cart	29
Overhead-bagged storage	5	Bucket	19
Stable grain room	12		
Storage in feed alley or in front of cows	20		
Storage in separate building	2		
Total	46	Total	48

On more than half the farms, unloading time, time in getting grain to the feed alley, and the carrying of 100-pound bags had been minimized by arrangements for receiving and storing grain. Table 21 presents a summary of distances observed.

Table 21. Distonces in Unloading, from Grain Storage to Feed Alley, and in Carrying 100-pound Bags Between Storage and Feed Alley, Selected Dairy Farms

	Numbers of Farms Reporting		
Distance in Feet	Distance from Truck to Grain Stoiage	Distance from Grain Storage to Feed Alley	Distance 100 lb. Bags Carried Between Grain Storage and Feed Alley
None	29	31	21
1-10	14	6	5
11-20	4	4	4
21-30	2	6	5
31-40	1	1	0
41-50	1	0	0
51-60	1	2	1
61-70	0	2	0
Total	52	52	36

The greater the distance over which grain must be carried between truck and grain storage, the greater the time per bag required in unloading. Minimizing this distance in locating grain storage facilities would increase the efficiency of grain delivery and decrease the time required of farm help who may assist in unloading.

Another locational consideration is the distance from the grain storage to the feed alley. As this distance increases, so does the time required in grain feeding. In a number of cases 100-pound bags were carried varying distances in the transfer of grain from storage to feed alley. This lifting could probably be avoided entirely by minor changes in methods.

Some Grain-Feeding Arrangements for Dairy Farms.

Some of the types of arrangements for receiving, storing, and feeding grain on dairy farms are diagrammed below. Six represents a completely mechanized setup similar to that developed at Penn. State.* Another possible mechanization in a pen-stable milking-parlor arrangement can be achieved by modification of 8. Such a change would be toward metering feeders and a drag conveyor, as developed at Michigan State.†

An Appraisal of Several Feeding Arrangements.

Table 22 measures approximately the effects of alternative methods of grain handling and feeding upon equipment overhead and operating and labor costs. Under Situation A, it is assumed that we are working with the 25-cow herd previously mentioned in the text, where grain was stored in an overhead-grain room, and the operator carried or dropped bagged grain downstairs and filled the grain cart. Under these conditions it took 20 minutes per day to feed. With Situation B, he installed an overhead-bulk bin from which he filled the grain cart and feeding time declined to 10 minutes daily. Under Situation C, it is assumed the operator installed the Penn. State Mechanical system for stanchion stables with bulk feed, and cut feeding time to 2.5 minutes daily.‡

It is apparent that the time savings from installing an overhead-bulk bin and downspout are more than sufficient to offset the overhead costs on the additional investment, even without taking into account a savings in the purchase price of bulk vs. bagged feed. Installing the mechanical system, however, causes overhead and operating costs of such magnitude that they more than offset resultant time savings. However, considered with the bulk feed savings, the net results might be closer to net results with Situation A. Nevertheless, Situation B still appears to represent the best choice of the three methods.

The preceding comparisons dealt with alternatives in a stanchion stable. The same approach can be applied to feeding grain in a milking parlor. There is probably little difference in time required for grain feeding with either a stanchion stable or a milking parlor, when similar facilities and practices exist. It is contended by some that grain feeding can be more effectively combined with other chores in a milking parlor, whereas in a pen-stable it is more or less a distinct operation. On the other hand, with a milking parlor, the operator must go to the feed supply and make the rounds of the stalls with each new batch let in for milking. This arrangement might mean fewer feet of travel, but probably no less time in the aggregate for the grain feeding operation.

Hence, in Situations D and E, it is assumed that the daily grain feeding times equal 20 and 10 minutes, respectively. With D it is assumed that there is an overhead-grain room. The operator carries or drops bags of grain downstairs, fills a storage barrel in the milking parlor, and feeds out of this barrel with a scoop scale. With the latter (E) it is assumed that an overhead-bulk bin with a downspout is constructed. The barrel can then be filled periodically by gravity flow. Under Situations F and G, it is assumed that a

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* Penn. State Mechanical Dairy Feeder, Penn. Agr. Exp. Sta., Progress Report No. 110, Nov., 1953.

† Letter from Dept. of Agr. Eng., Mich. State College, East Lansing, Mich., May 6, 1954.

‡ This system consists essentially of an automatic poultry feeder with elevating and conveying features to fill a series of telescoping feed meters. Meters are set individually as necessary to deliver the desired amount of grain to each cow. A time switch operates the feeder. Each meter is connected to the feed release mechanism — which is operated by pulling a handle at one end of the stable.

bulk bin is installed and that metering devices will be used on the downspouts. The difference between F and G is that the former is assumed to be completely mechanized* and the latter dependent upon gravity flow† to the metering devices. For both Situations F and G, where the feeding operation itself is identical, it is assumed that daily feeding time will be six minutes, or somewhat in excess of the completely mechanized stanchion-stable arrangement in Situation C.

In comparing Situations D and E in Table 22, it is again apparent that constructing the overhead-bulk bin with downspout results in time savings more than sufficient to offset the depreciated value of the additional investment, even without taking into account a savings in the purchase price of bulk vs. bagged feed. While the cost of a mechanized system is somewhat less in the milking parlor than in a stanchion stable — 3 stalls vs. 25 stanchions to be fitted with downspouts and meters — it still does not effect as much net savings as a bulk bin and downspout alone. The real potential of the metering feeder would best be realized if we could service these 3 outlets by gravity from a bulk bin rather than by overhead conveying equipment.

It must be acknowledged that the starting point for the analyses in Table 22, i.e., an overhead grain room from which the operator carries bagged or drops grain downstairs to fill a grain cart or barrel, is not the most efficient means of handling bagged feed. However, it may be fairly

Table 22. Estimated Annual Costs of Chore Feeding of Grain to a 25-Cow Herd Under Assumed Situations[1]

Item of Cost	Stanchion Stable			Milking Parlor			
	A $	B $	C $	D $	E $	F $	G $
Equipment depreciation	2.50[2]	15.00[3]	112.50[4]	1.10[5]	13.60[6]	70.00[7]	22.50[8]
Interest, insurance, taxes	.61	3.71	27.83	.27	3.37	17.32	5.56
Repairs and maintenance	.25	1.50	21.25	.11	1.36	12.75	3.00
Operating costs	—	—	50.00	—	—	50.00	—
Sub-total	3.36	20.21	211.58	1.48	18.33	150.07	31.06
Labor cost in feeding[9]	121.66	60.83	15.21	121.66	60.83	36.50	36.50
Total	125.02	81.04	226.79	123.14	79.16	186.57	67.56

[1] Situations explained in text.
[2] Homemade grain cart, scoop scale.
[3] Homemade grain cart, scoop scale, bulk bin.
[4] Bulk bin, automatic feeder, 25 stanchion meters.
[5] Scoop scale, storage barrel.
[6] Scoop scale, storage barrel, bulk bin.
[7] Bulk bin, automatic feeder, 3 metering feeders.
[8] Bulk bin, 3 metering feeders.
[9] Hours at $1.00 per hour.

* This system approximates the Michigan State plan for milking parlors. It is assumed that an automatic poultry feeder with elevating and conveying features will be used to fill a series of hoppers. On the downspouts, metering feeders, operating on the principal of an auger in a tube, turned by a handle, will be located. These deliver about two pounds per revolution of the handle, depending on density of the grain. Commercial companies retail this device for about $25 each.

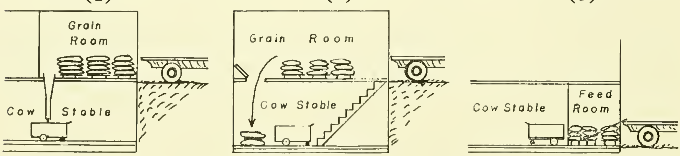
† It is assumed in Situation G that the bulk bin can be modified so that gravity flow will fill a hopper above each metering device.

representative in terms of grain feeding time of practices on many New Hampshire farms. Probably a well located grain room off the stanchion stable would be almost as efficient in terms of grain feeding time as an overhead-bulk bin and downspout, but not nearly so desirable in terms of the amount of physical effort or the cost of feed. There is another advantage inherent in the bulk method — release of space which might be used for other purposes.

In any study involving time savings, these are of real value only if time saved can be put to productive use or if a real decrease in hired labor costs is realized.

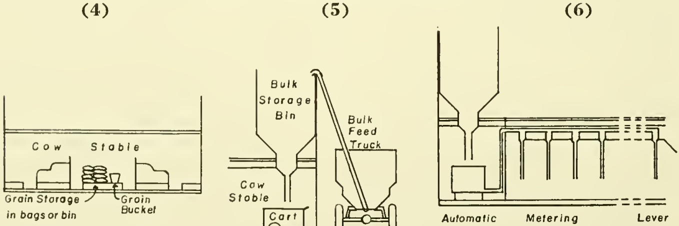
Size of herd undoubtedly has considerable bearing upon the selection of an optimum method of feeding grain. As size increases, the cost of extra construction and mechanization equipment per unit tends to decline. There is also a tendency for labor requirements per unit to decline. Where bulk feed is concerned, there are herd sizes below which the feed dealer will not wish to go in extending bulk-feed service. With every-other-week delivery, a 20-25 cow herd could use a ton of grain about every two weeks.

(1) (2) (3)



Left: grain storage on barn floor, downspout to feed cart in basement stable. Center: grain storage on barn floor. Operator climbs stairs from basement stable, throws down bag of grain through trap door, and empties this into feed cart. Right: grain storage at ground level in room off stable. Bags unloaded from truck onto chute.

(4) (5) (6)



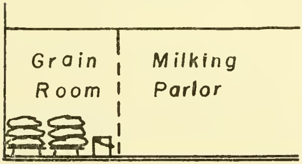
Left: grain stored in stable feed alley. In another variation, grain is stored in bags in a feed room and bags emptied into a bin near feed alley. Bucket is used in feeding. Center: grain stored in a bulk bin located above the stable. Downspout to feed cart. Right: grain stored in a bulk bin located above the stable. This is the Pennsylvania State mechanical dairy feeder. A downspout fills automatic poultry feeder unit. Endless chain fills individual meters above each stanchion. These are set individually. A hand lever is pulled to open meter-bottom slides. A rather costly installation.

Figure 10. Some grain-feeding arrangements in stanchion stables on dairy farms.

If the minimum amount were two tons, such a unit would be able to use a load every four weeks. With company policies and inadequate knowledge about the keeping characteristics of feed, it is difficult to pinpoint exactly the minimum-sized herd which can come under bulk-feed service.

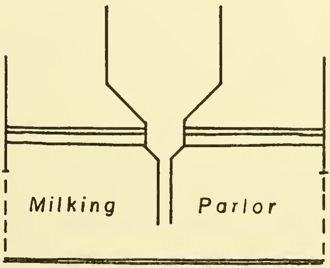
For New Hampshire conditions, this translates itself into two groupings, those to whom bulk feed is unavailable and who should progress toward the most efficient means of handling bagged feed, and those to whom bulk feed is available and who can take advantage of gravity flow. It does not seem at this time that the plans for complete mechanization of feeding grain to milk cows are as desirable costwise as bulk feed gravity-flow arrangements.

(7)



Grain stored in small room off milking parlor. Bucket used in feeding.

(8)



Grain stored in bulk bin located above the milking parlor. Downspout to (a) bucket used in feeding, or (b) barrels used to store day's supply. Possible variation toward mechanization include bulk bin, automatic feeder, endless chain, and meters, or several downspouts from bulk bin to meters. The former is similar to Michigan State milking room feeder.

Figure 11. Grain-feeding arrangements in pen stables and milking parlors on dairy farms.

Dry Cows and Young Stock.

Most of what has been said with respect to milk cows will apply to dry cows and young stock, insofar as stanchion stables are concerned. With loose housing, or pen stables, the problem of feeding grain is somewhat different. First, there may be no central point through which the animals pass. Second, the problem of feeding different amounts of grain is less important than with milk cows. Feeding grain to such animals in pen stabling might be similar to the feeding of beef cattle, where little or no attempt can be made to see that each animal gets a certain amount, but only that an average of so much grain per head is fed. There are mechanical systems for feeding hay, silage, and grain to beef cattle. The various feed items are generally mixed together and conveyed to the feeding area. Because of the relatively small numbers of animals involved on New Hampshire dairy farms, such methods do not seem to have general applicability at this time.

5. Conclusions

THE question of improving the efficiency of the receiving and handling of grain-feeds on farms is, in application, best approached on an individual unit basis. Neither farm layouts nor management factors are standardized. Thus, the design of facilities can only rarely be identical from farm to farm. The objective in this bulletin has not been to present a complete list of possibilities, but to suggest a few, leaving application to ingenuity. Some specific designs for feed handling facilities are available from college and trade sources.

Farm operators need to ration capital expenditures. The choice of improvement projects can be made by considering the net savings various changes yield. Feed handling is likely to rank near the top of the list for poultrymen, but much lower for dairymen.

Having feed delivered to the farm in bulk does not necessarily assure significant time savings. What counts more is the feeding arrangements and mechanization into which bulk feed can readily fit.

Savings in the purchase price of bulk feed must ultimately reflect some of the savings, if any, in handling costs of feed companies. Initial discounts may tend to reflect in addition what competing feed companies offer as an incentive to farmers to convert to bulk feed.

Although difficult to quantify, the effects of improved methods of receiving and handling feeds on the labor force are important. Taking the "lift and lug" out of feed handling may not only enhance the attractiveness of farm work and permit family members to perform chores in emergencies, but may also contribute to the productivity of regular workers at tasks other than feeding.

The adoption of the pneumatic-type equipment, either in regular bulk delivery trucks or in the attachment of a unit to bagged delivery trucks, has added to the flexibility of farm systems for handling feed. One of the major problems in simplification has been that of economically locating supplies at convenient points. The pneumatic system is admirably suited for this purpose.

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